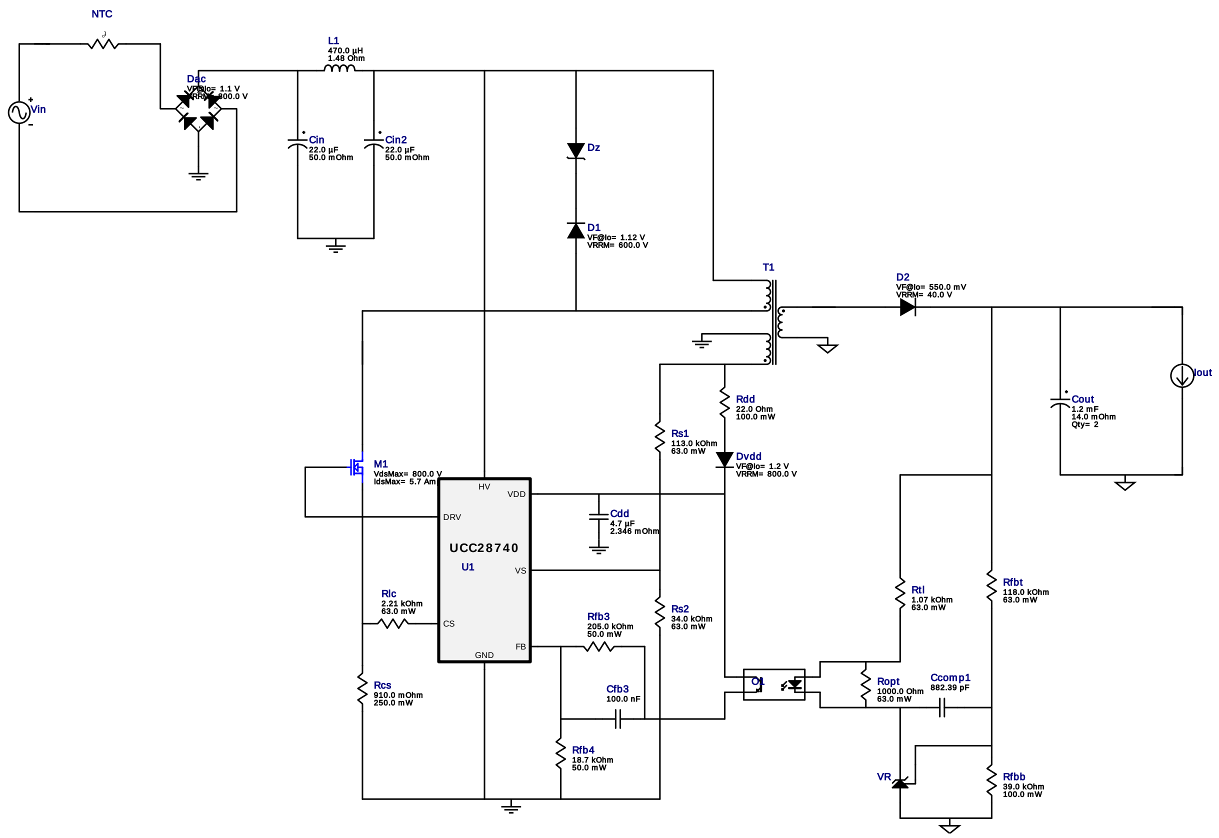
VinMin = 85.0V
VinMax = 265.0V
Vout = 5.0V
Iout = 3.0A

Device = UCC28740DR
Topology = Flyback
Created = 2023-02-17 11:21:00.612
BOM Cost = NA
BOM Count = 30
Total Pd = 3.35W

WEBENCH ® Design Report

Design : 18 UCC28740DR
UCC28740DR 85V-265V to 5.00V @ 3A



1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.
2. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

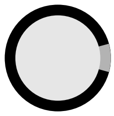
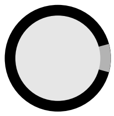
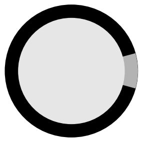
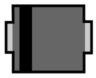
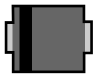
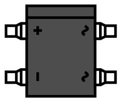
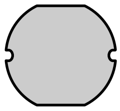
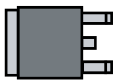
Design Alerts

Component Selection Information

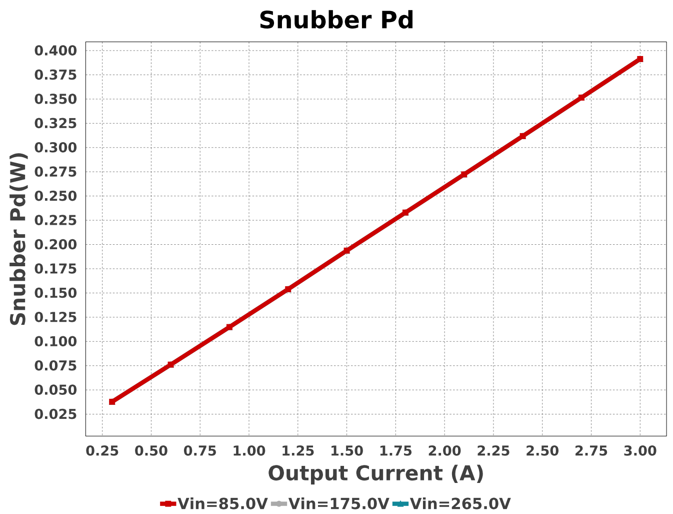
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

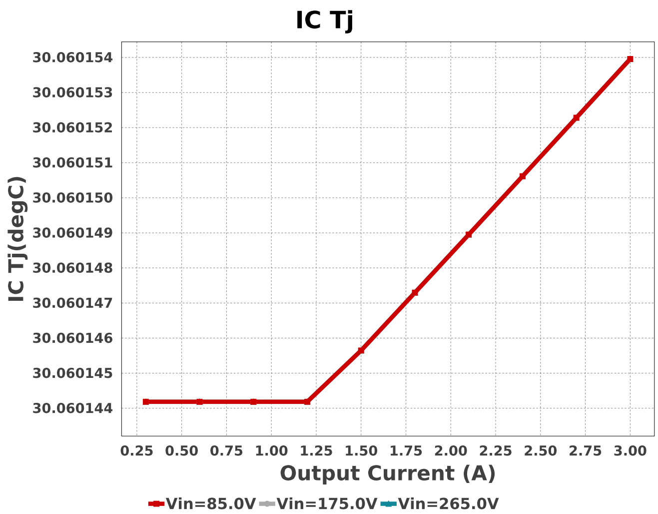
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp1	CUSTOM	CUSTOM Series= ?	Cap= 882.39 pF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
Cdd	TDK	CGA4J1X7R1V475K125AC Series= X7R	Cap= 4.7 uF ESR= 2.346 mOhm VDC= 35.0 V IRMS= 4.2602 A	1	$0.13	0805 7 mm^2
Cfb3	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm^2

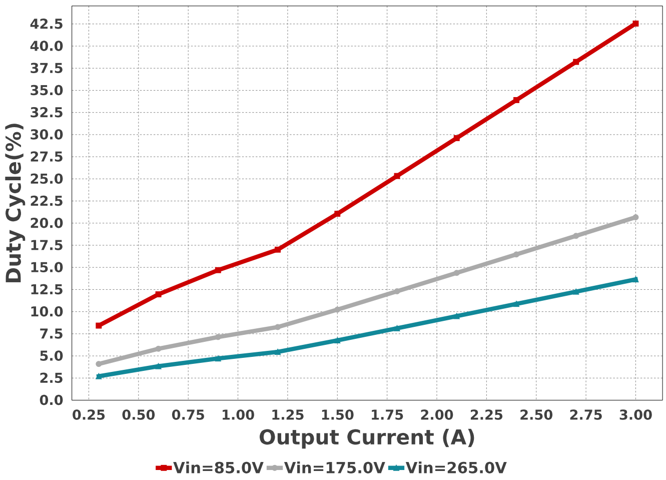
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	Rubycon	400PK22MEFC12_5X20 Series= PK	Cap= 22.0 uF ESR= 50.0 mOhm VDC= 400.0 V IRMS= 200.0 mA	1	$0.39	 CAPPR7 144 mm^2
Cin2	Rubycon	400PK22MEFC12_5X20 Series= PK	Cap= 22.0 uF ESR= 50.0 mOhm VDC= 400.0 V IRMS= 200.0 mA	1	$0.39	 CAPPR7 144 mm^2
Cout	Nichicon	UHV1V122MHD Series= HV	Cap= 1.2 mF ESR= 14.0 mOhm VDC= 35.0 V IRMS= 3.19 A	2	$0.54	 CAPPR5-12.5X25 210 mm^2
D1	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.23	 SMC 83 mm^2
D2	Diodes Inc.	B540C-13-F	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.19	 SMC 83 mm^2
Dac	Vishay-Semiconductor	DF08SA	VF@Io= 1.1 V VRRM= 800.0 V	1	$0.28	 DF-S 99 mm^2
Dvdd	Microsemi	UFS180JE3/TR13	VF@Io= 1.2 V VRRM= 800.0 V	1	$0.95	 DO-214BA 42 mm^2
Dz	Diodes Inc.	SMBJ110A-13-F	Zener	1	$0.10	 SMB 44 mm^2
L1	NIC Components	NPI105C471MTRF	L= 470.0 µH 1.48 Ohm	1	$0.14	 IND_NPI105C 141 mm^2
M1	Infineon Technologies	IPD80R1K0CEBTMA1	VdsMax= 800.0 V IdsMax= 5.7 Amps	1	$0.60	 DPAK 102 mm^2
NTC	GE Sensing	CL-40 Series= CL	Thermistor	1	$0.86	 Thermistor_CL-40 164 mm^2
O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$1.32	 SSOP-4 111 mm^2
Rcs	Bourns	CRM0805-FX-R910ELF Series= ?	Res= 910.0 mOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.04	0805 7 mm^2
Rdd	Yageo	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfb3	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfb4	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbb	Yageo	RC0603FR-0739KL Series= ?	Res= 39.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Vishay-Dale	CRCW0402118KFKED Series= CRCW..e3	Res= 118.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rlc	Vishay-Dale	CRCW04022K21FKED Series= CRCW..e3	Res= 2.21 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ropt	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rs1	Vishay-Dale	CRCW0402113KFKED Series= CRCW..e3	Res= 113.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rs2	Vishay-Dale	CRCW040234K0FKED Series= CRCW..e3	Res= 34.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rtl	Vishay-Dale	CRCW04021K07FKED Series= CRCW..e3	Res= 1.07 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
T1	Core=TDK , CoilFormer=TDK	Core=B66311G0000X127 , CoilFormer=B66206C1012T001	Lp= 688.0 µH Turns Ratio(Nas)= 17:5 Turns Ratio(Nps)= 81:5 Npri= 81.0 Naux= 17.0 Nsec= 5.0	1	$1.07	TDK_B66305 245 mm^2
U1	Texas Instruments	UCC28740DR	Switcher	1	$0.38	R-PDSO-G7 55 mm^2
VR	Texas Instruments	LMV431CM5/NOPB	Voltage References	1	$0.20	R-PDSO-G3 16 mm^2

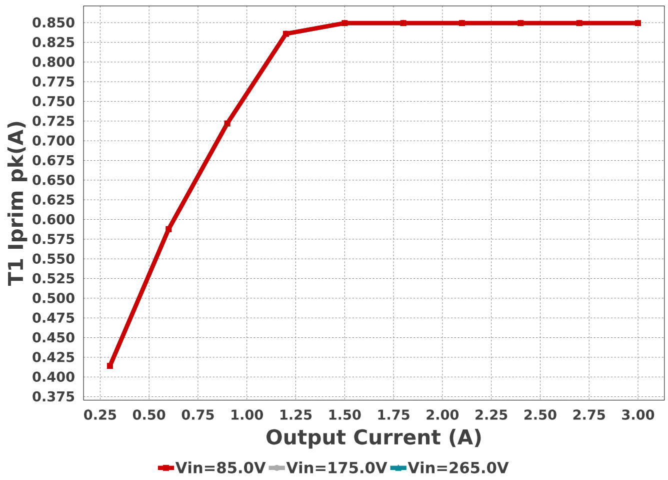




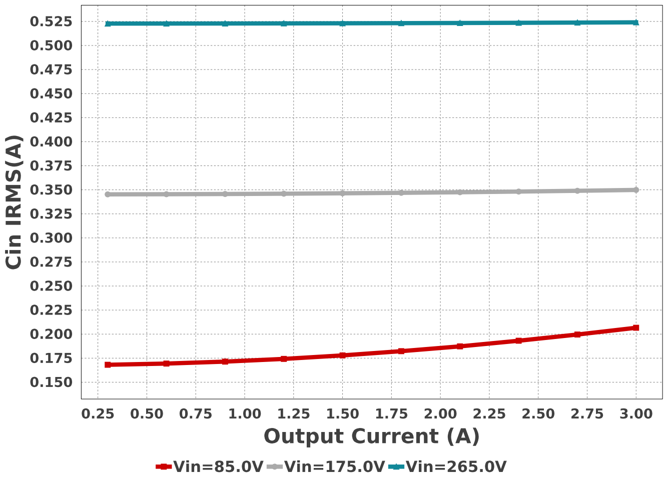
Duty Cycle



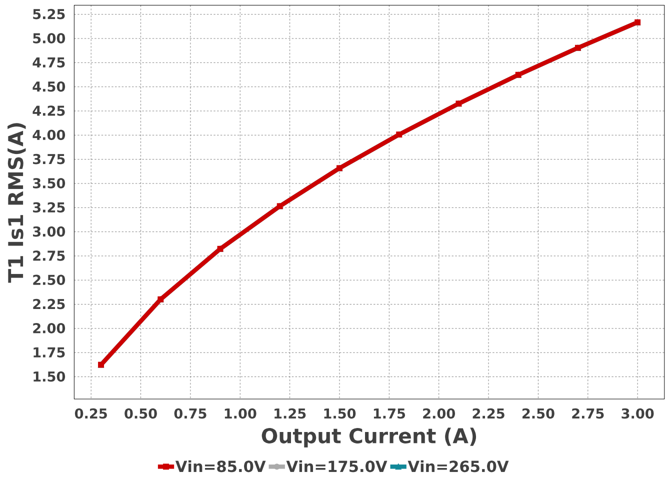
T1 Iprim pk



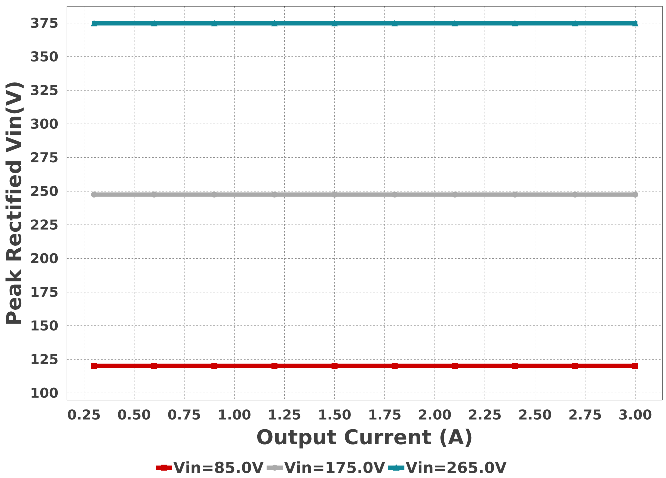
Cin IRMS



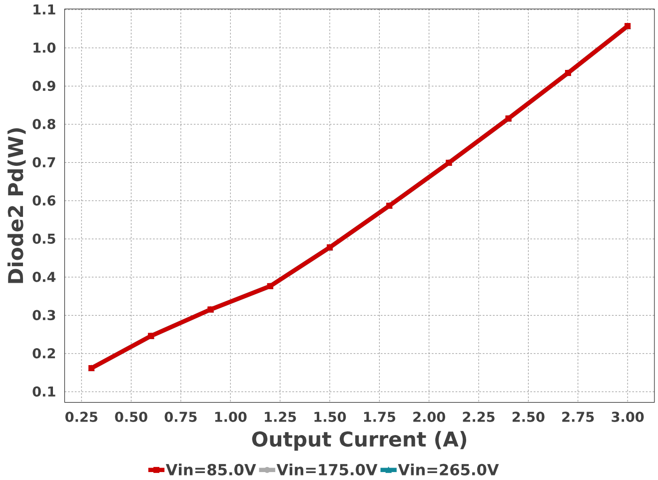
T1 Is1 RMS



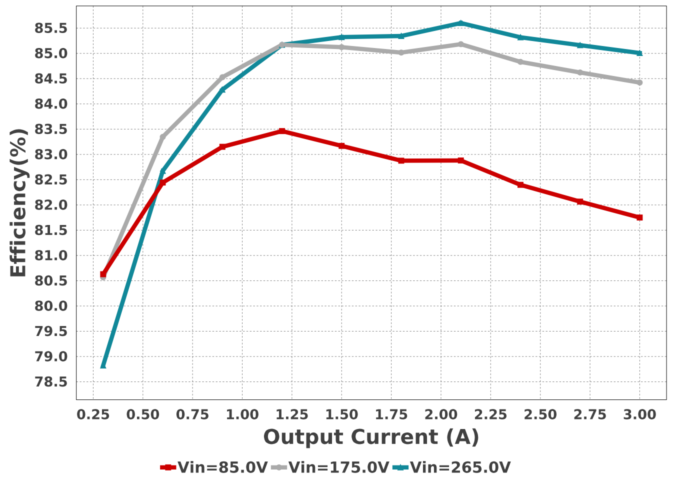
Peak Rectified Vin



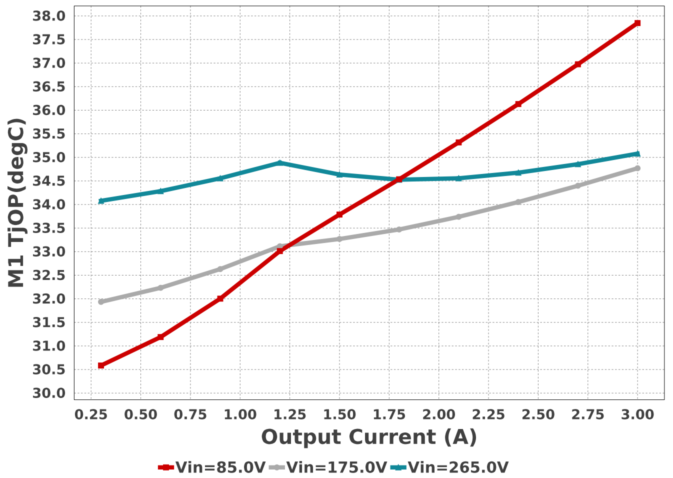
Diode2 Pd



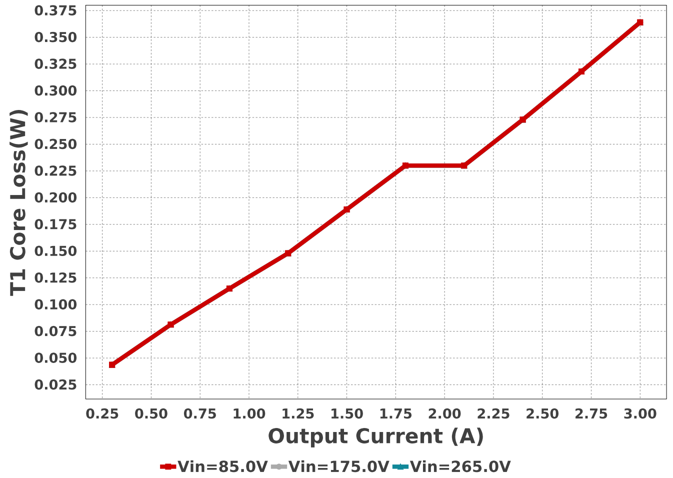
Efficiency



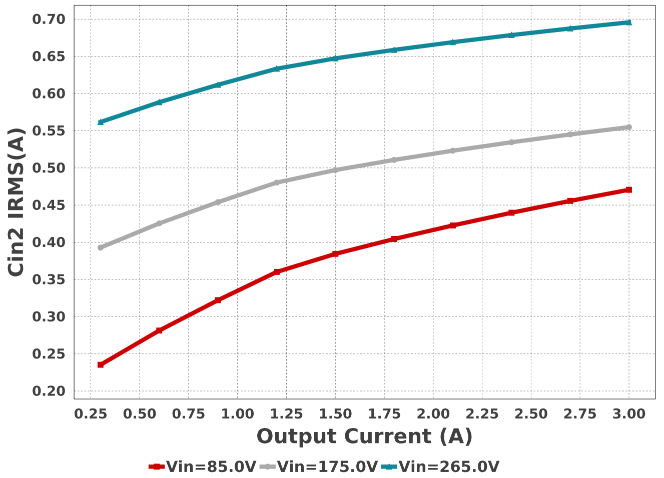
M1 TjOP



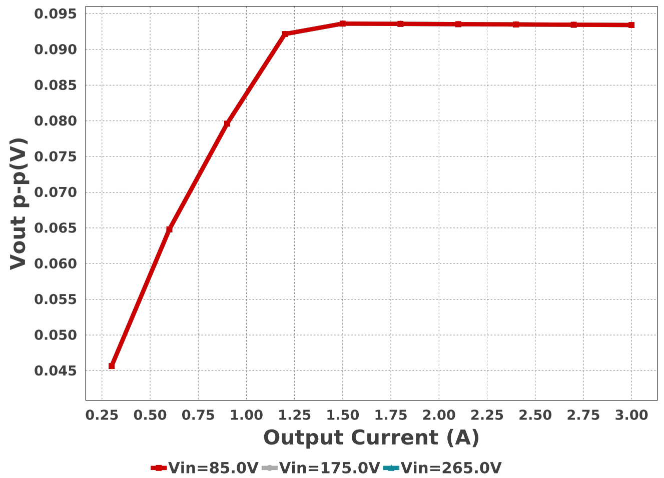
T1 Core Loss



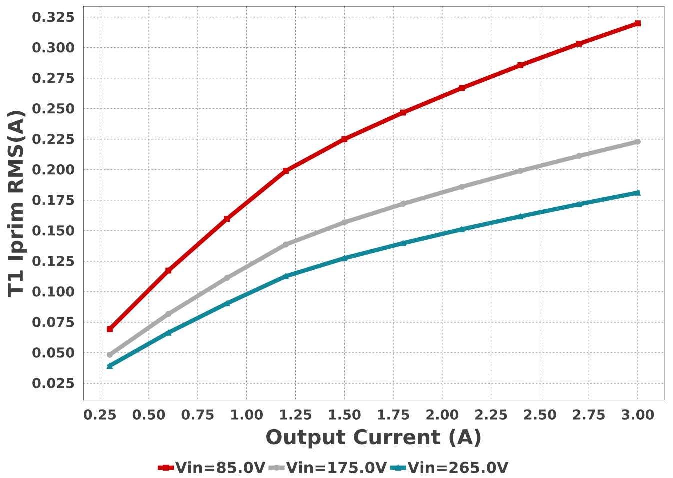
Cin2 IRMS

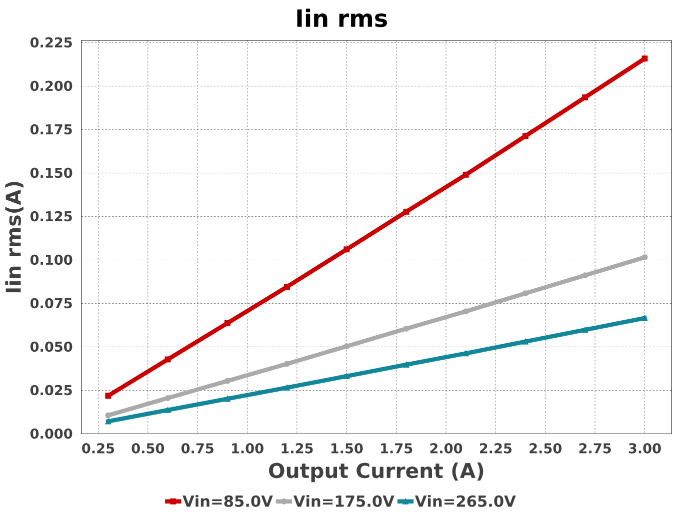


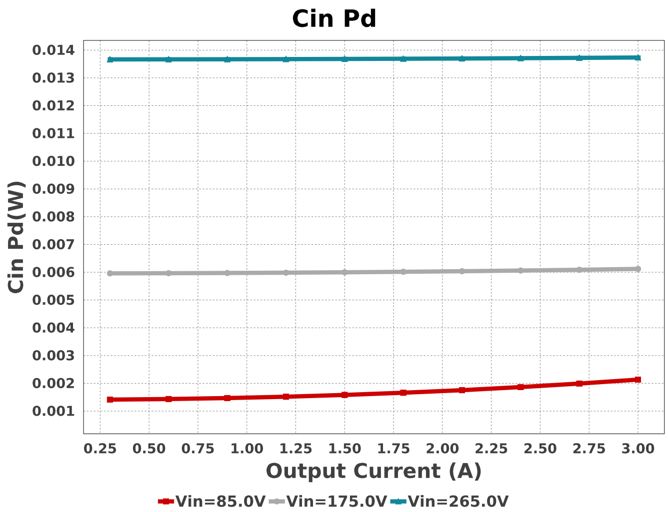
Vout p-p

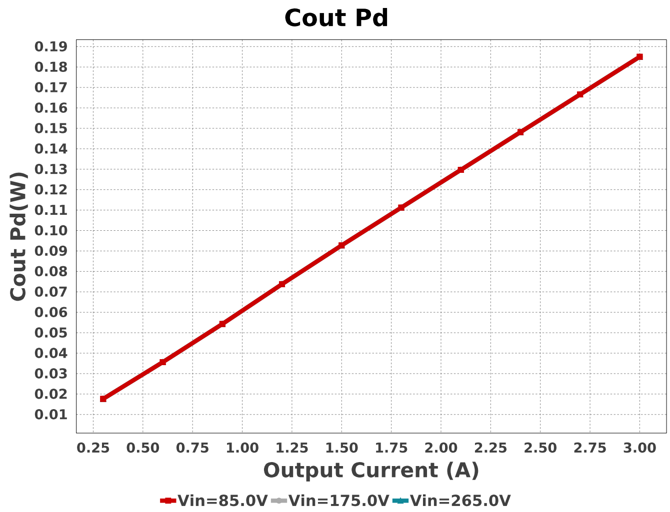


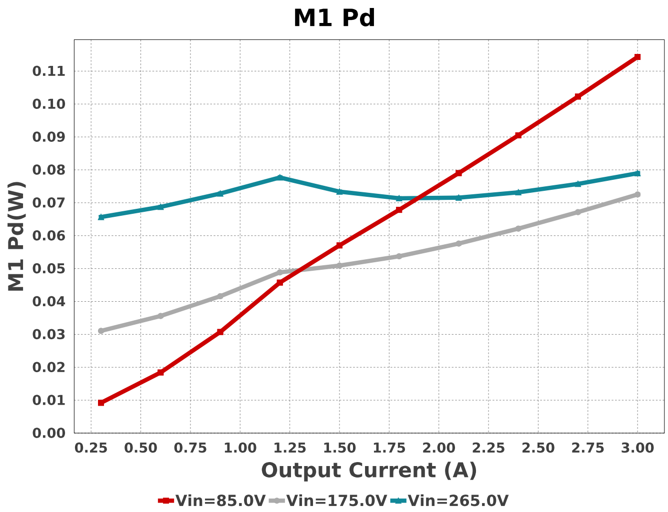
T1 Iprim RMS

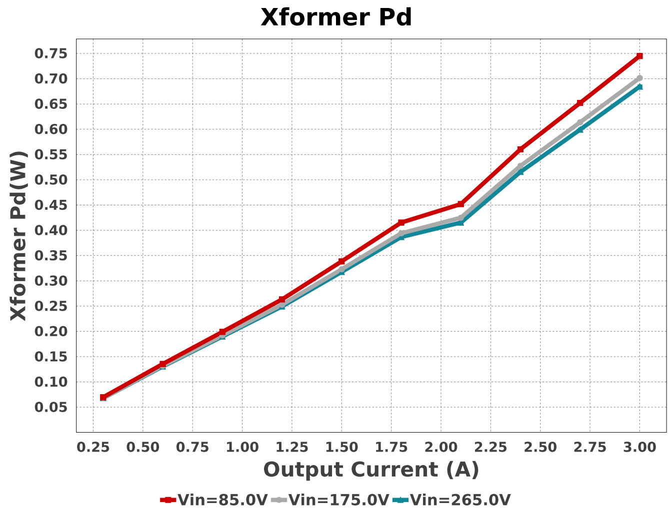


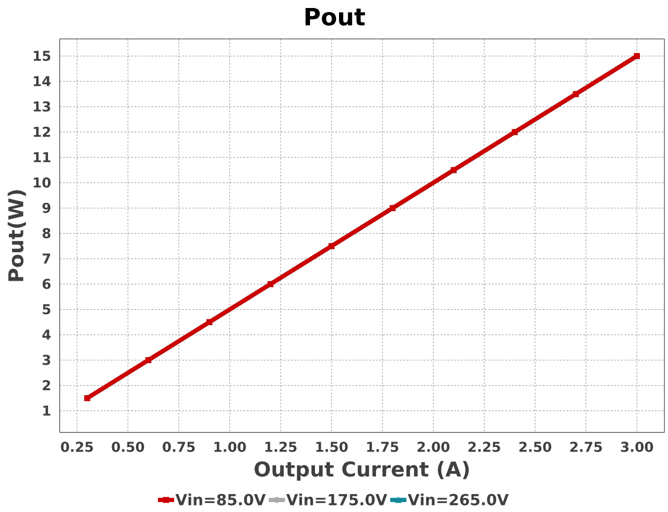

Iin rms
Iin rms(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Cin Pd
Cin Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

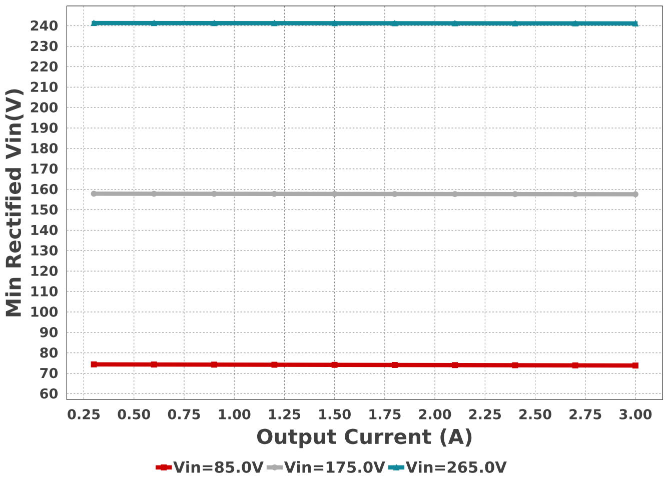

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

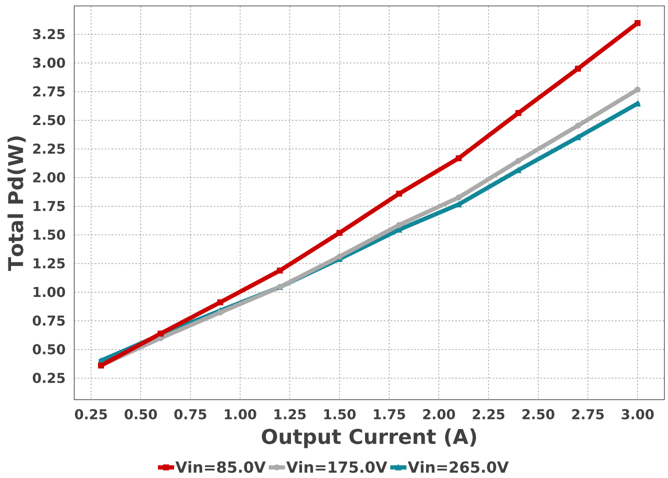

Xformer Pd
Xformer Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Pout
Pout(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

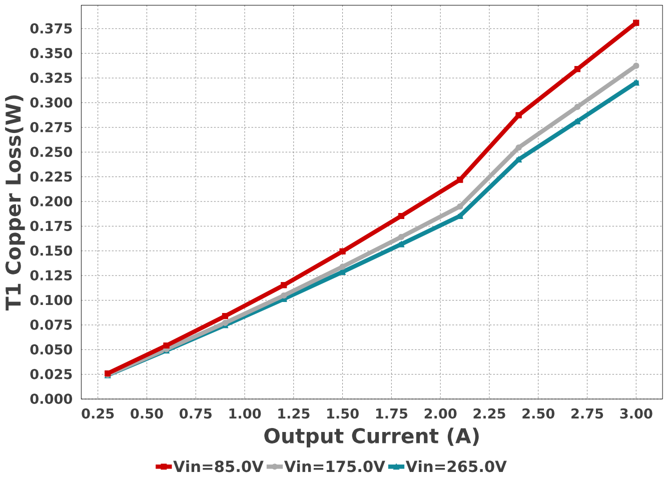
Min Rectified Vin



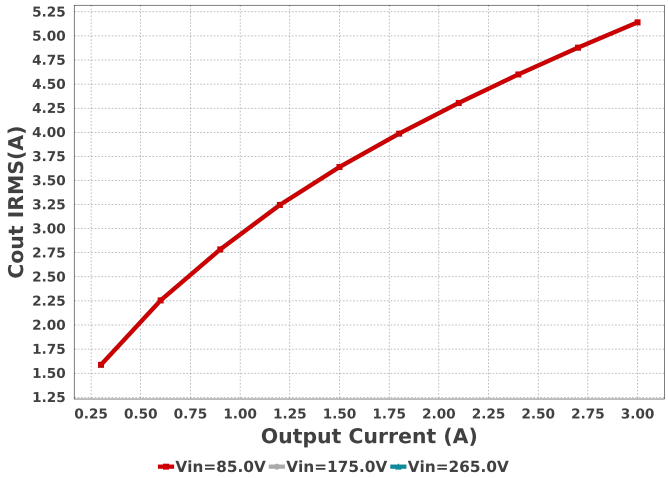
Total Pd



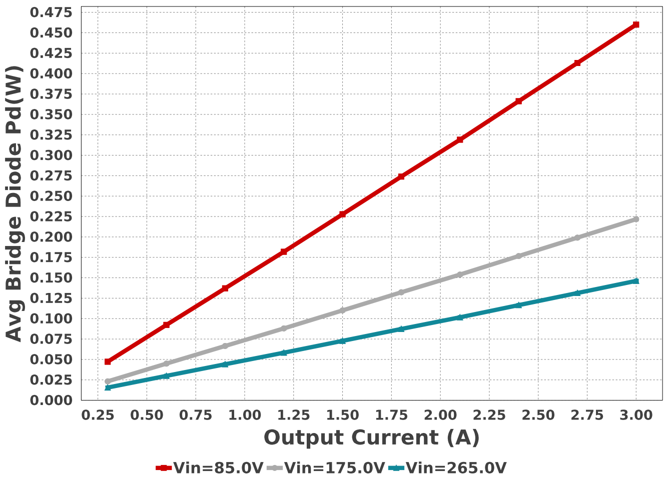
T1 Copper Loss



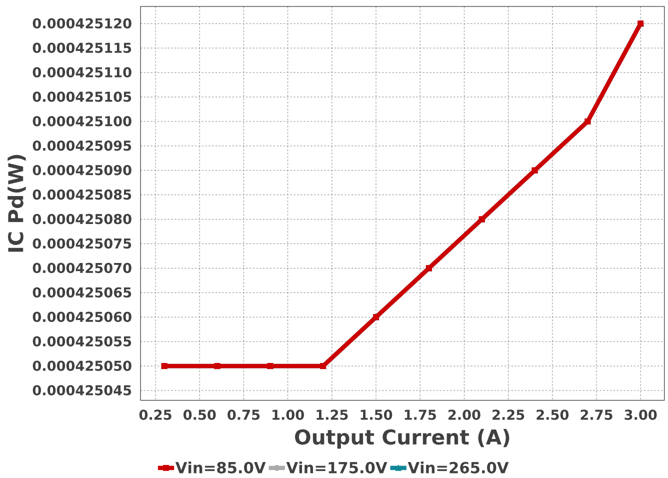
Cout IRMS

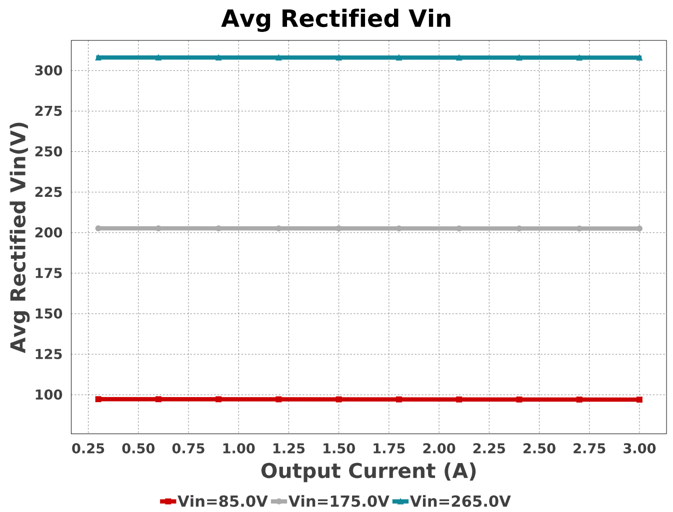


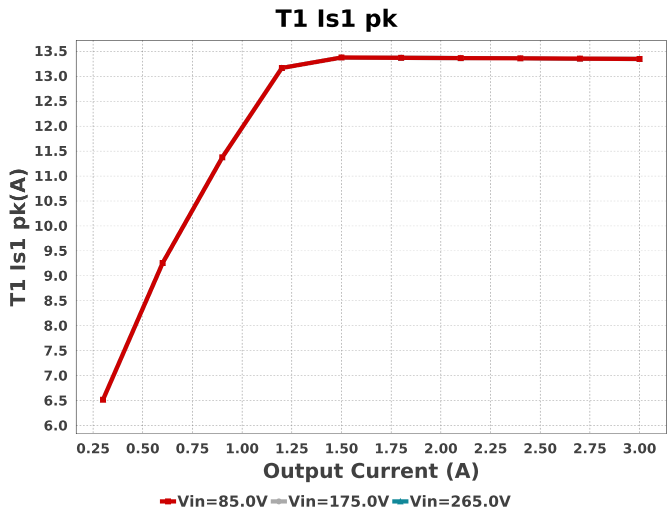
Avg Bridge Diode Pd



IC Pd







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	30		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	206.595 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	2.134 mW	Capacitor	Input capacitor power dissipation
5.	Cin2 IRMS	470.555 mA	Capacitor	Input Capacitor Cin2 RMS Ripple Current
6.	Cout IRMS	5.141 A	Capacitor	Output capacitor RMS ripple current
7.	Cout Pd	185.01 mW	Capacitor	Output capacitor power dissipation
8.	Avg Bridge Diode Pd	459.95 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
9.	Diode2 Pd	1.057 W	Diode	Diode2 power dissipation
10.	IC Pd	425.12 µW	IC	IC power dissipation
11.	IC Tj	30.06 degC	IC	IC junction temperature
12.	ICThetaJA	141.5 degC/W	IC	IC junction-to-ambient thermal resistance
13.	M1 Pd	114.3 mW	Mosfet	M1 MOSFET total power dissipation
14.	M1 TjOP	37.849 degC	Mosfet	M1 MOSFET junction temperature
15.	Avg Bridge Diode Pd	459.95 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
16.	Cin Pd	2.134 mW	Power	Input capacitor power dissipation
17.	Cout Pd	185.01 mW	Power	Output capacitor power dissipation
18.	Diode2 Pd	1.057 W	Power	Diode2 power dissipation
19.	IC Pd	425.12 µW	Power	IC power dissipation
20.	M1 Pd	114.3 mW	Power	M1 MOSFET total power dissipation
21.	Snubber Pd	391.325 mW	Power	Snubber Power Dissipation
22.	T1 Copper Loss	380.88 mW	Power	Transformer Copper Loss Power Dissipation
23.	T1 Core Loss	364.0 mW	Power	Transformer Core Loss Power Dissipation
24.	Total Pd	3.348 W	Power	Total Power Dissipation
25.	Xformer Pd	744.88 mW	Power	Transformer power dissipation
26.	Avg Rectified Vin	97.009 V	System Information	Average Rectified Voltage for the AC Line Period
27.	Duty Cycle	42.542 %	System Information	Duty cycle
28.	Efficiency	81.751 %	System Information	Steady state efficiency
29.	FootPrint	1.95 k mm^2	System Information	Total Foot Print Area of BOM components
30.	Frequency	78.78 kHz	System Information	Switching frequency
31.	Frequency	78.78 kHz	System Information	Switching frequency
32.	Iin rms	215.86 mA	System Information	RMS Input Current
33.	Iout	3.0 A	System Information	Iout operating point
34.	Min Rectified Vin	73.81 V	System Information	Minimum voltage seen at rectified input
35.	Mode	DCM	System Information	Conduction Mode
36.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
37.	Pout	15.0 W	System Information	Total output power
38.	Vin_RMS	85.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
39.	Vout	5.0 V	System Information	Operational Output Voltage
40.	Vout Actual	10.064 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Tolerance	1.843 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	93.42 mV	System Information	Peak-to-peak output ripple voltage
43.	T1 Copper Loss	380.88 mW	Transformer	Transformer Copper Loss Power Dissipation
44.	T1 Core Loss	364.0 mW	Transformer	Transformer Core Loss Power Dissipation
45.	T1 Iprim RMS	319.879 mA	Transformer	Transformer Primary RMS Current
46.	T1 Iprim pk	849.451 mA	Transformer	Transformer Primary Peak Current
47.	T1 Is1 RMS	5.167 A	Transformer	Transformer Secondary1 RMS Current
48.	T1 Is1 pk	13.346 A	Transformer	Transformer Secondary1 Peak Current
49.	Xformer Pd	744.88 mW	Transformer	Transformer power dissipation

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	5.0	Output Voltage
acFrequency	50.0	AC Frequency
base_pn	UCC28740	Base Product Number
source	AC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

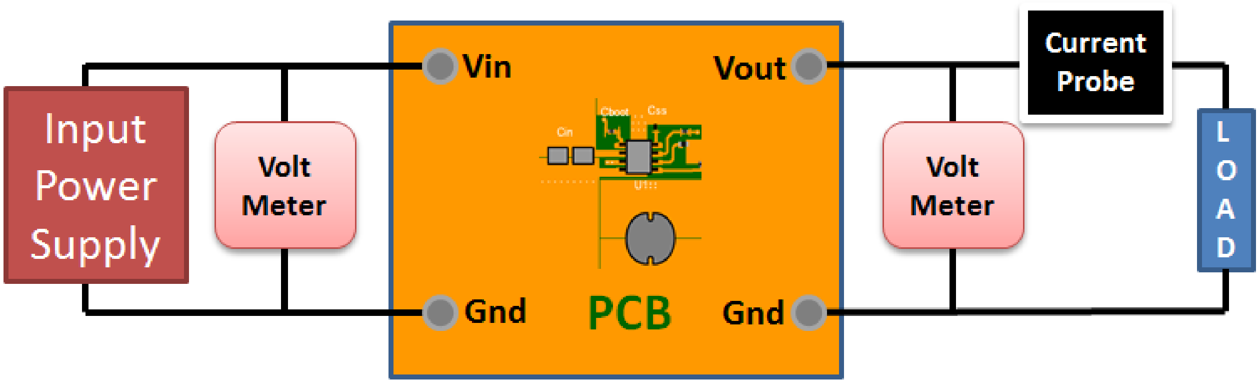
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 85.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B66311G0000X127
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66206C1012T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	82.0
AWG	25.0
Layers	4.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	5.0
AWG	26.0
Layers	1.0
Strands	3.0
Insulation Type	Triple Insulated

Auxiliary

Turns	17.0
AWG	28.0
Layers	1.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/4.0	25.0	41	Clockwise
Auxiliary	28.0	17.0	Counter Clockwise
Triple Insulated Secondary	26.0	5.0	Counter Clockwise
Primary Second 2/4.0	25.0	41	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	6.88E-4H
2.	Inductance Factor(Al)	103.0nH
3.	Npri	82.0
4.	Nsec	5.0
5.	Naux	17.0
6.	Core Type	E20/10/6
7.	Core Material	N27

#	Name	Value
8.	Bmax	0.22T
9.	Switching Frequency	76.50kHz
10.	DMax	0.5
11.	Ipk(Primary)	0.85A
12.	Irms(Primary)	0.35A
13.	Ipk(Secondary)	13.9A
14.	Irms(Secondary)	5.24A

Design Assistance

1. Application Hints Rlc Rlc provides the function of feed-forward line compensation to eliminate change in IPP due to change in di/dt and the propagation delay of the internal comparator and MOSFET turn-off time. For best results the chosen value may need to be adjusted based on board, FET and transformer parasitics. Rtl Rtl is added to prevent excessive diode current and limit Iopt to the maximum value necessary for regulationThe Rtl value may be adjusted for optimal limiting later during the porotype evaluation process. Rfbt & Rfbb The feedback resistors will set the output voltage of the circuit. The values chosen may need to be fined tuned based on the final Transformer turns ratios and the voltage across the output diode at close to zero current. Rfb3 & Cfb3 Rfb3 is necessary to limit the current into FB and to avoid excess draining of Cvdd during this type of transient situation.The value of Rfb3 is chosen to limit the excess Ifb and Rfb4 current to an acceptable level when the optocoupler is saturatedCfb3 helps improve the transient response and is estimated initially by equating the time constant to 1ms. This can later beadjusted for optimal performance during prototype evaluation Rfb4 Rfb4 speeds up the turnoff time of the optocoupler in the case of a heavy load-step transient condition. This value tends to fallwithin the range of 10k and 100k. A tradeoff must be made between a lower value for faster transient response and a higher value forlower standby power. Rfb4 also serves to set a minimum bias current for the optocoupler and to drain dark current Part Description The UCC28740 isolated-flyback controller provides Constant-Voltage (CV) using an optical coupler toimprove transient response. Constant-Current (CC) regulation is accomplished through Primary Side Regulation (PSR) techniques. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28740.pdf

2. Master key : 5601E6D956368EA766F626A92E56EDD0[v1]

3. **UCC28740** Product Folder : http://www.ti.com/product/UCC28740 : contains the data sheet and other resources.